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ON THE RELATIONSHIPS AND DISTRIBUTION OF  
THE NORTH AMERICAN UNIONIDÆ, WITH  
NOTES ON THE WEST COAST SPECIES.

BY CHAS. T. SIMPSON.

For some years past, it has been generally acknowledged by students of the Unionidæ that a more natural system of classification was needed for that family than any that has hitherto been offered.

The genera or sub-genera of Rafinesque, Swainson, Agassiz and Conrad are of little value, for while certain typical species may be fairly referred to their divisions, in many others the characters fade out, or so blend together that it is impossible to place them, and sub-generic lines cannot be drawn with any degree of accuracy. Lea's arrangement, in which he divided the genera into two great groups, characterized by the presence or absence of a dorsal wing on the shell, and then into smaller divisions based on sculpture and form, was, like the Linnæan classification in botany, almost entirely artificial, consequently in many cases it brought together side by side forms not at all nearly related, and in others it widely separated those having close affinities, or even sometimes individuals of the same species.

I believe that the best and simplest system that can be adopted at the present, at least, is to place those species, which by the characters of the shell, by what we know of those of the animal, and by the facts of geographical distribution are most nearly related, in groups, each founded on and taking its name from some common, characteristic, and widely distributed form. Thus *Unio gibbosus*, which is nearly everywhere found throughout the Mississippi drainage area, is well known to every collector who has only a few species of Unios, and, with its elliptic oval and sometimes arcuate outline, thick epidermis, heavy cardinal and solid club-shaped lateral teeth, fairly typifies an assemblage of forms found from Canada to Central America, and from the Missouri river to Florida. *Unio liga-*

*mentinus* represents another section, *Unio complanatus* another, *Margaritana margaritifera* a fourth, *Anodonta ovata* a fifth, and so on.<sup>1</sup>

This plan of grouping by relationships is not a new one, having been adopted by R. Ellsworth Call, Wm. A. Marsh, and other students of the Unionidæ in the arrangement of their collections, and even Mr. Lea acknowledged some such affinities, though he did not put his ideas into practice.

It is found that a common assemblage of Unionidæ inhabits the entire Mississippi drainage basin, and that a considerable number of the species have a distribution covering the greater part of this area, as well as the whole of Texas, and even parts of eastern Mexico.

Those streams which fall into the Atlantic are peopled by an entirely different set of forms, the Appalachian chain seeming to act as a sharp barrier between the two regions. Many of the Mississippi Valley species have spread into Michigan, a few into Canada, into streams in New York that flow into the Atlantic, and two or three of these are met with in the Red River of the North, and the waters about Hudson Bay; while below the southern end of the mountain range, there is another mingling of groups.<sup>2</sup>

There are some forms which, apparently, may be with equal propriety assigned to either of two or three groups, but, in such cases, the location of the species with regard to drainage often gives us a key as to its relationship. There is a group of oval, rather smooth, compressed Unios, which may be fairly typified by *U. favosus*, which is found in the rivers from North Carolina to Alabama, several members of which very strongly

<sup>1</sup> With such an arrangement, I believe that the North American Unios would fall into something like forty quite natural assemblages, whose group characters agree fairly well with their distribution so far as drainage areas are concerned. There would be some half dozen sections of *Margaritana*, and ten or a dozen of *Anodonta*.

<sup>2</sup> In many cases, the Unionidæ seem to have had no difficulty in migrating across the country from river to river; an example of this being the Mississippi Valley species which now inhabit all the rivers of Texas, and some of those of Eastern Mexico; while on the other hand species of South America extend up into Central America. The embryos, in some cases, may be carried by aquatic birds in the manner elsewhere mentioned in this paper; in others, they probably migrate across overflowed regions near the sea, in time of floods.

resemble some of those of the Clavus Group, but the species of the latter assemblage are confined, with one or two exceptions, to the streams of the Mississippi Basin, while those of the former belong entirely in waters falling into the Atlantic or the Gulf. Another small group of rounded or oval inflated forms typified by *U. irrasus* likewise approaches in a few of its members some of the species of the *clavus* Group, but it is confined, so far as my knowledge goes, to the waters of the Gulf drainage; the Etowah, Coosa, Chattahoochee, and a few neighboring streams, and not a specimen has, I believe, ever come from Tennessee or the rivers emptying into the Atlantic, though several of them rise near the Chattahoochee.

In Mexico and Central America, a totally different Unio fauna is found. Some of the Anodons extend into South America, and others belong to groups that have their metropolis on that Continent, while at the North there is a greater or less mingling of the species with those of the Mississippi Valley.

I have been greatly puzzled to account for the origin and relations of the few species found on the Pacific slope of North America. Two Unios, one Margaritana, and some half dozen Anodons, are all that have been hitherto credited to this immense region. Of the latter, *Anodonta wahlametensis*, *A. nuttalliana*, *A. oregonensis*, and *A. californiensis*, are believed by Dr. Stearns<sup>3</sup> and other competent conchologists to be merely variations of one species, although they often differ greatly in forms and general appearance. *A. wahlametensis* is provided with a wide dorsal wing, which gradually fades out through the other forms in the order I have given them, to *A. californiensis*, which is nearly or quite destitute of this appendage. This very abundant species is found from the Rocky Mountains on the east—in all the waters draining into the Pacific—to the coast, and from British Columbia on the north, well into Mexico on the south. Six shells in the collection of the United States National Museum (Mus. No. 117951), which were identified by Dr. Stearns as *Anodonta californiensis*, were collected by Mr. Duges in the Province of Oajacay.

<sup>3</sup> See paper on the History and Distribution of the Fresh Water Mussels, and Identity of Certain Alleged Species, by R. E. C. Stearns, Proc. Cal. Acad. Sci., Nov. 20th, 1882.

To the northward, this seems to be replaced by *Anodonta kennerlyi*, a species closely resembling some of the varieties of *A. cygnea* of Europe, and in Alaska another nearly related form, *A. youkonensis* of Lea, is met with. The latter is an absolute synonym of *A. herculea* Midd., of which specimens are in our collection, obtained in Kamschatka by Dr. Dall. I had noticed the resemblance of all these forms to that of the well known, abundant, variable, and widely distributed *Anodonta cygnea* and its variety *anatina*, and on hunting up the distribution of that species, I have been able to trace it through Northern Asia into Eastern Siberia. Any one who will carefully examine an extensive series of *Anodonta cygnea*, *anatina*, *herculea*, *youkonensis*, *kennerlyi*, *wahlametensis*, *nuttalliana*, *oregonensis*, and *californiensis*, cannot, I think, fail to notice their remarkable resemblance in many essential points: the peculiar and usually exact rounding of the anterior end of the shell, the flattening of the umbonal region, which, in good specimens, is generally overlaid with hair-like, greenish, radiating, wavy lines, and the singular cutaway in the posterior slope, all indicate close relationship, and the fact that they have sprung from a common origin.

I should unhesitatingly place these forms in a natural group, typified by *Anodonta cygnea*. Dr. Stearns, in the paper to which I have already alluded, believes that *Anodonta wahlametensis*, *nuttalliana*, *oregonensis*, and *californiensis*, are but variations of the European *A. cygnea*, and that *A. fluviatilis* of the Atlantic drainage is probably but another form of this protean species.

While I was formerly inclined to this view, a more careful and thorough examination of large quantities of material has induced me to somewhat modify my opinions. Though the *nuttalliana* and its variations are very close to *cygnea*, I do not, at present, feel justified in uniting them specifically, and I regard the *A. fluviatilis* as the type of a rather nearly related group, having a distribution from Canada to Florida, in the streams which fall into the Atlantic. The shells of this section are generally more inflated than those which belong with *cygnea*; they are not flattened at the umbonal region, and are more full on the dorsal slope.

If I am right in this view of the case, it is probable that the group of *Anodonta cygnea* is confined in North America to the Pacific slope, and that its connection with the rest of the species in the Old World was made over a land passage between Asia and North America. Dr. Theodore Gill informs me that the boreal fresh-water fishes of the Old World and those of the western slope of our continent have a similar distribution to the *cygnea* group of Anodons as I have outlined it.

One of the most remarkable of the Unionidæ, *Anodonta angulata*, is an inhabitant of the waters of Oregon, Washington, and California. The anterior end of this species in ordinary specimens is much narrowed; the posterior is wide and inflated, and, running from the beaks to the posterior ventral regions is an extraordinarily developed sharp-edged ridge or keel. Nothing in the least resembling this peculiar form has hitherto been found. But the National Museum possesses specimens in which the anterior end is wider, and the keel is far less developed, and others in which it is almost entirely wanting, and that indefatigable collector, Mr. Henry Hemphill, has sent me a photograph of a specimen in his collection which has no vestige of a ridge, but is furnished with a slight groove running down the posterior slope. Recently, Messrs Mearns and Holzner, of the International Boundary Commission, have sent to the National Museum a large number of specimens of what is apparently a new species of *Anodonta*, from San Bernardino Ranch, Arizona, which, externally, very much resembles some of the varieties of *Unio complanatus*, but has a very different texture, and, on comparing these shells with Mr. Hemphill's photograph, and the more compressed specimens of *A. angulata*, I was convinced at once that they group together. They have the same outline, the same beak sculpture, and, when viewed from the dorsal or ventral region, have a much greater diameter through the posterior area than elsewhere, and nearly all exhibit the slight groove I have mentioned.

The type of *Unio oregonensis* was presented to Mr. Lea by Mr. C. M. Wheatley, and the former mentions that the latter reserved a specimen for his own collection. Lea's shell is said to come from the Columbia River, and is in rather bad condi-

tion, as it is dead and somewhat eroded. I have very carefully examined it, and after comparing it with everything that I could think might be related to it, I have come to the conclusion that it is a form of the protean *Unio luteolus*.

This is the most abundant, widely distributed, and variable *Unio* in the world, being found almost everywhere throughout the 1,200,000 square miles of the Mississippi drainage basin, through Texas, and probably into Mexico, in New York in some of the streams that flow into the Atlantic, and northward in the vicinity of Hudson Bay, and probably throughout the British possessions east of the Rocky Mountains. I have traced it up the Missouri River to near its source, and when it is taken into consideration that the Marias, a tributary of this stream, heads within a few miles of Flathead Lake on Clarkes River, a branch of the Columbia, and that the embryos of *Unios* are provided with hooks by which they can attach themselves to the feet or feathers of aquatic birds, it is very easy to see how this species might have been carried from the waters of one drainage system to those of another. *Margaritana margaritifera*, which inhabits Europe, Northern Asia, and the Pacific slope of North America, is also found in the upper Missouri. Two specimens of *Unio luteolus* in the Museum collection, from the North Shore of Lake Superior, are almost exactly like Lea's type of *U. oregonensis*.

So far as I am aware, nothing is stated of *Unio famelicus*, the other Pacific slope species, save that Gould received his type from Dr. Pickering, and that it is said to have come from Walla Walla, Oregon. The type is in the National Museum, and is undoubtedly a young *Unio ellipticus* Spix, from Brazil, a species belonging to an extensive South American group, characterized by having oblong, compressed, sulcate shells, which are often granulated on the ridges. Any one familiar with *Unios* would know at once on carefully examining the type, that it came either from South America, or some part of the Southern Hemisphere of the Old World, a fact which is made evident by its form, its peculiar greenish olive epidermis, the strong growth lines, and, most of all, the compressed, parallel, cardinal teeth of the right valve. It is perfectly safe to say that the locality given is an error, and that this species was never found in the United States.